Radio Direction-Finding (RDF)

Dale Hunt WB6BYU 16 April 2011

Introduction

- What is RDF?
- Why would we use it for EMCOM?
  - ELT / EPIRB searches
  - Project Lifesaver (Alzheimer’s patients, etc.)
  - Locating sources of interference
  - Locating lost field teams
- Recreational / sport RDF
- Why am I standing up here?

Quick Summary

- RDF can be important in emergency response.
- Doesn’t require expensive or elaborate equipment (but specialized equipment can make it easier.)
- Equipment often can be improvised to meet a specific need.
- RDF is a skill that requires practice.
- RDF is a fun activity in non-emergency situations, which provides practice.

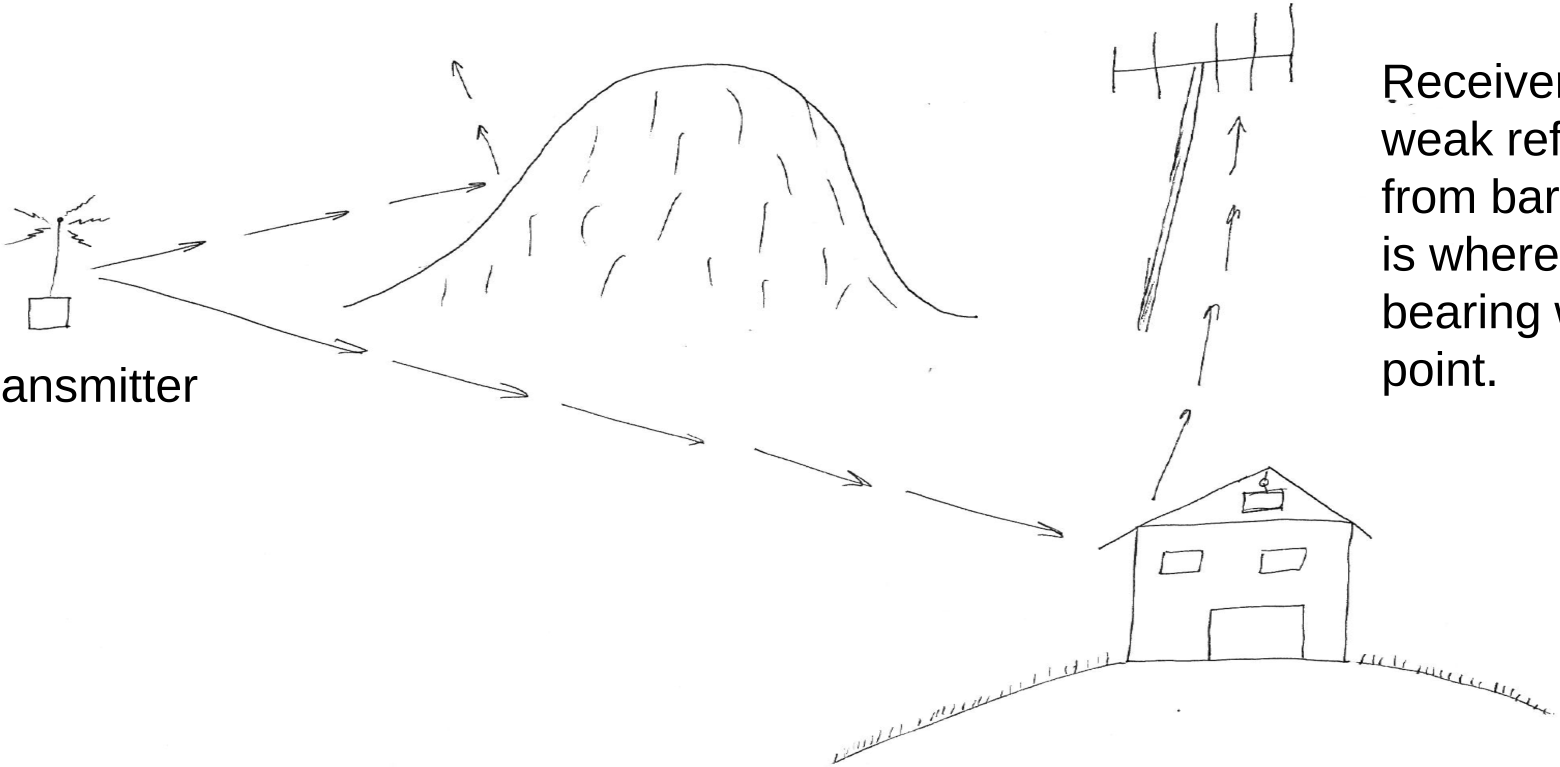
Radio Propagation Principles

- Signals travel in a straight line until reflected or absorbed.
  - Reflections and blockages make RDF more difficult, especially on VHF/UHF.

- Signals get weaker the further they travel.
  - Strength increases as you get closer.

- Signals loose strength at a reflection.
  - Put more trust in the strongest signals.

Sources of Confusion



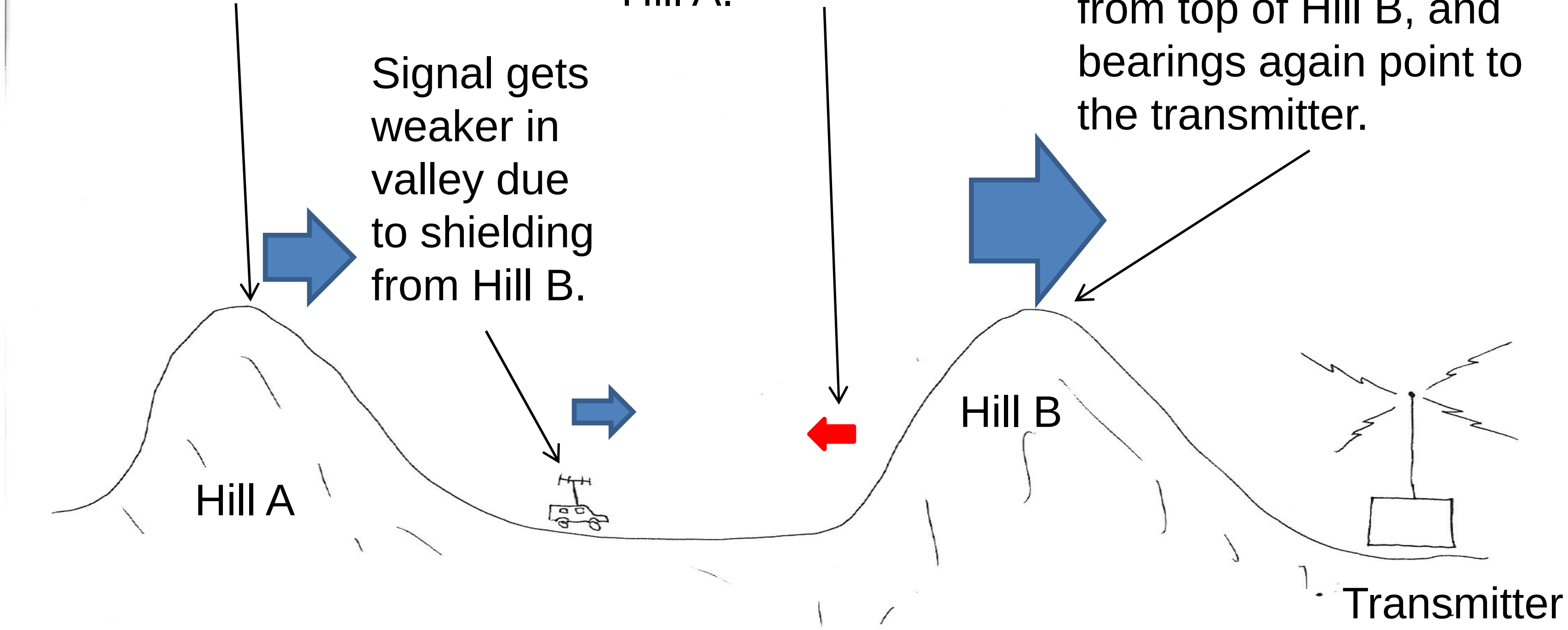
Hill blocks direct signal from transmitter

Receiver

Receiver hears weak reflection from barn. This is where the bearing will point.

Transmitter

A Common Problem



From top of Hill A, bearing points to transmitter with good strength.

Signal gets weaker in valley due to shielding from Hill B.

Signal is blocked by Hill B. Bearings **reverse**, pointing to the reflection from Hill A.

Signal is much stronger from top of Hill B, and bearings again point to the transmitter.

Following Clues

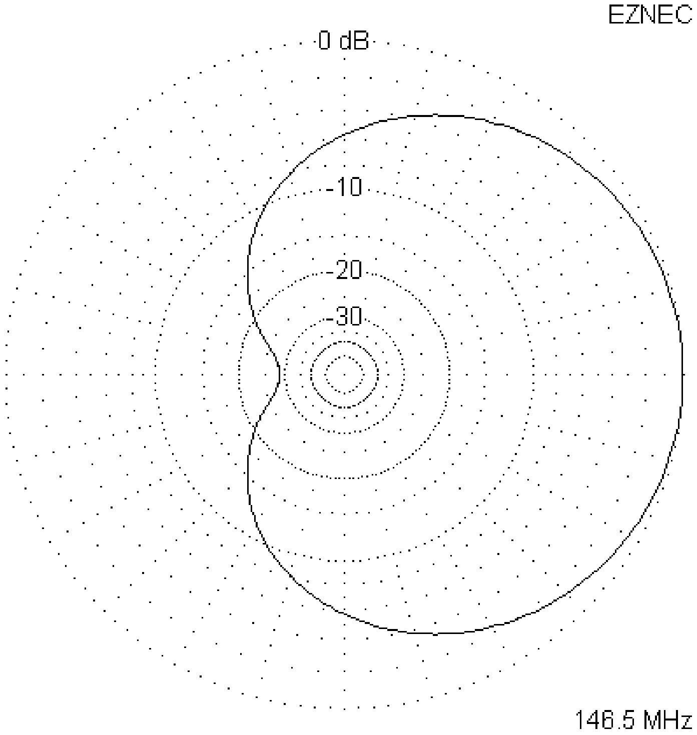
- RDF is all about following clues to the source of the signal. Important clues include:
  - Direction
  - Signal Strength
  - Rate of change in direction
  - Rate of change in signal strength
  - Terrain shadowing
  - Non-radio clues: keep your eyes open!

Tools for Determining Direction

- Antenna with directional pattern
- Some way to measure signal strength
- Some way to reduce signal strength as you get close to avoid receiver overload
    - “Attenuator”

EXAMPLE: “Body Shielding”

- Directional antenna:
  - Use your body as a reflector
  - Hold radio close to your chest.
  - Signal is weakest when your back is to the transmitter, so your body is shielding the radio.



Body Shielding (continued)

- Some way to measure signal strength
  - If receiver has no meter, listen to the background noise when the signal gets weak.
  - Background noise increases as signal gets weaker.

Body Shielding (continued)

- Some way to reduce signal strength
  - “Waveguide Beyond Cutoff” attenuator
  - Cardboard tube coated with aluminum foil.
  - Add a string to clip onto the radio.

We Used Our Tools

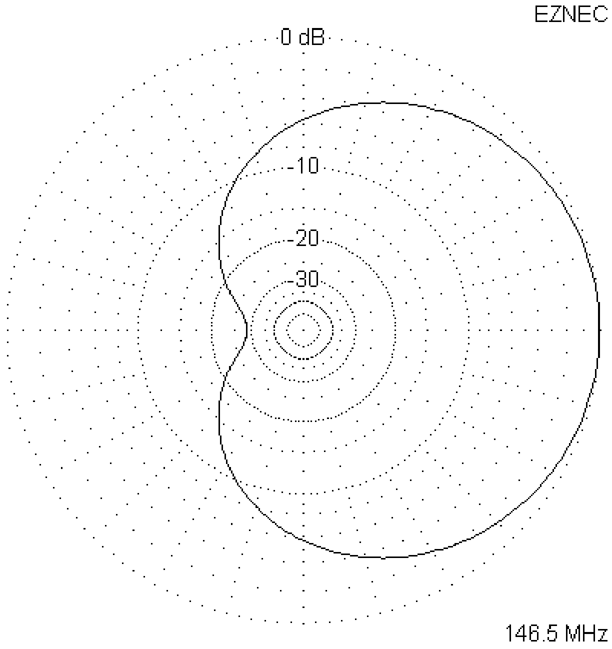
- Antenna with directional pattern
- Some way to measure signal strength
- Some way to reduce signal strength as you get close to avoid receiver overload
  - “Attenuator”

Receiver Choices

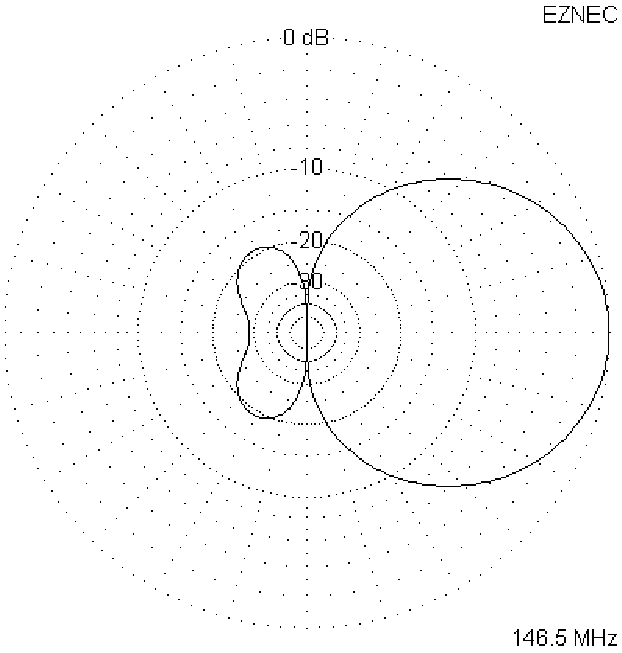
- Receiver for frequency (2m, SAR, marine, etc.)
  - Meter is useful, not required
  - NOT digital / trunking
- Wideband receiver
  - SSB/CW best for very weak signals
  - Allows harmonic sniffing
- Specialized receivers
  - L-Per
  - VK3YNG “Blue Box”

Directional Antennas

- Know the pattern of your antenna



Rotate for null (weakest signal)

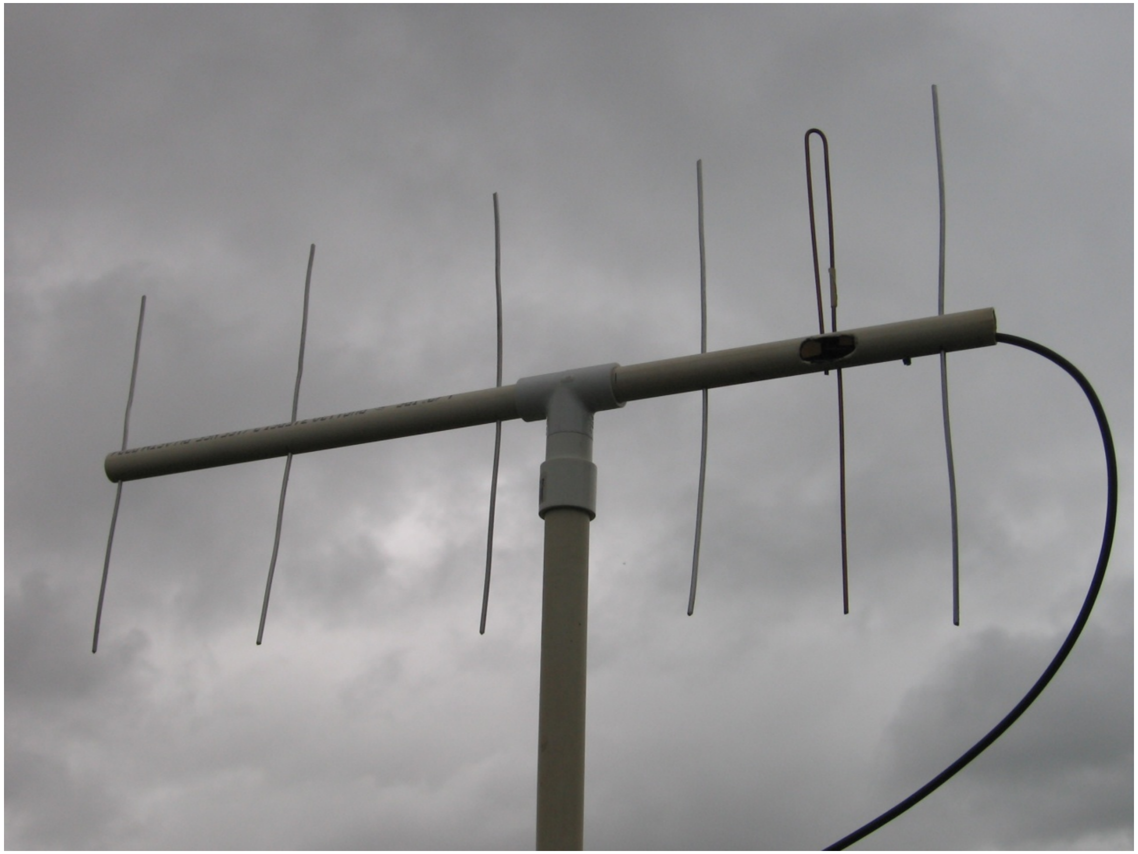


Rotate for strongest signal

Types of directional antennas

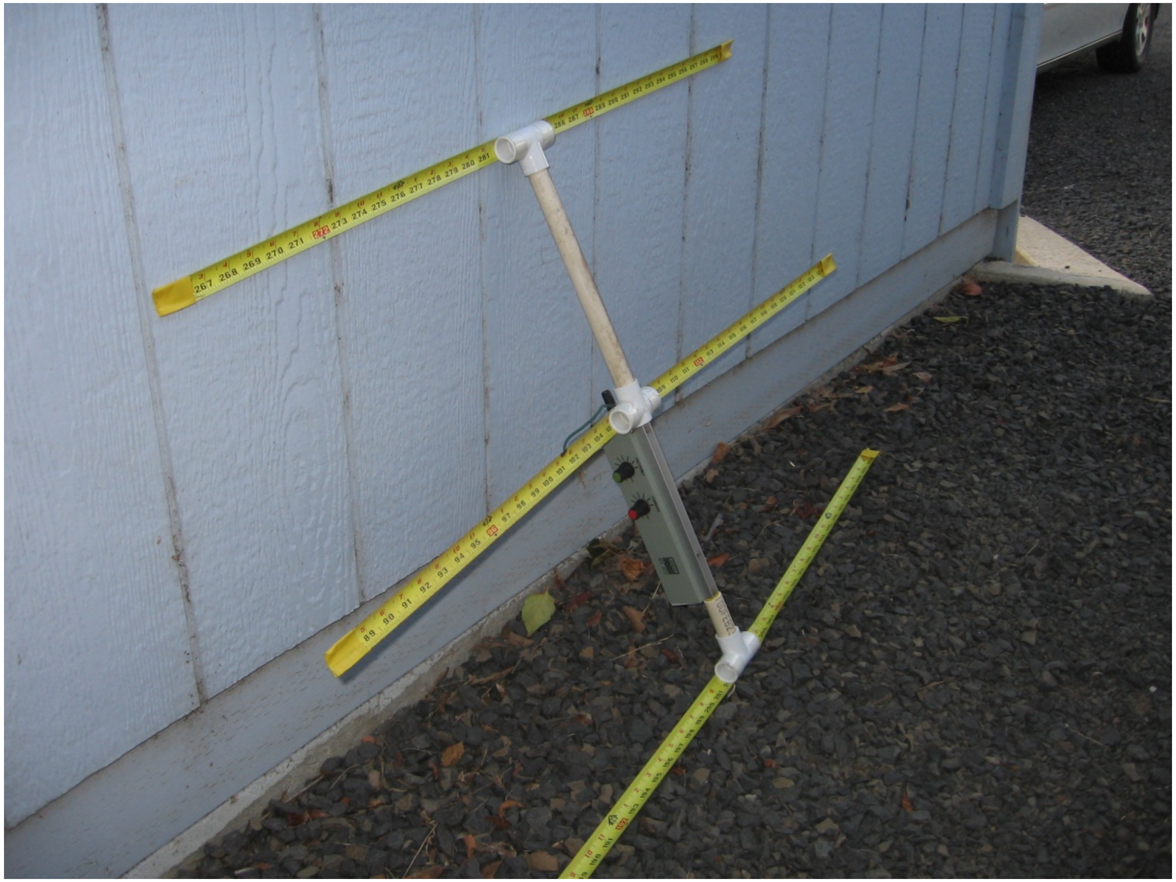
- Yagi
  - Long straight rods stuck through a boom
- Quad
  - Loops of wire arranged along a boom
  - Shorter vertically (more overhead clearance)
  - Slightly more mechanically complex to build
- Must be designed for the desired frequency
- Find a geek to help you out

6-Element Yagi for 450 MHz



Made with wire and PVC pipe.

3-Element Tape Measure Yagi

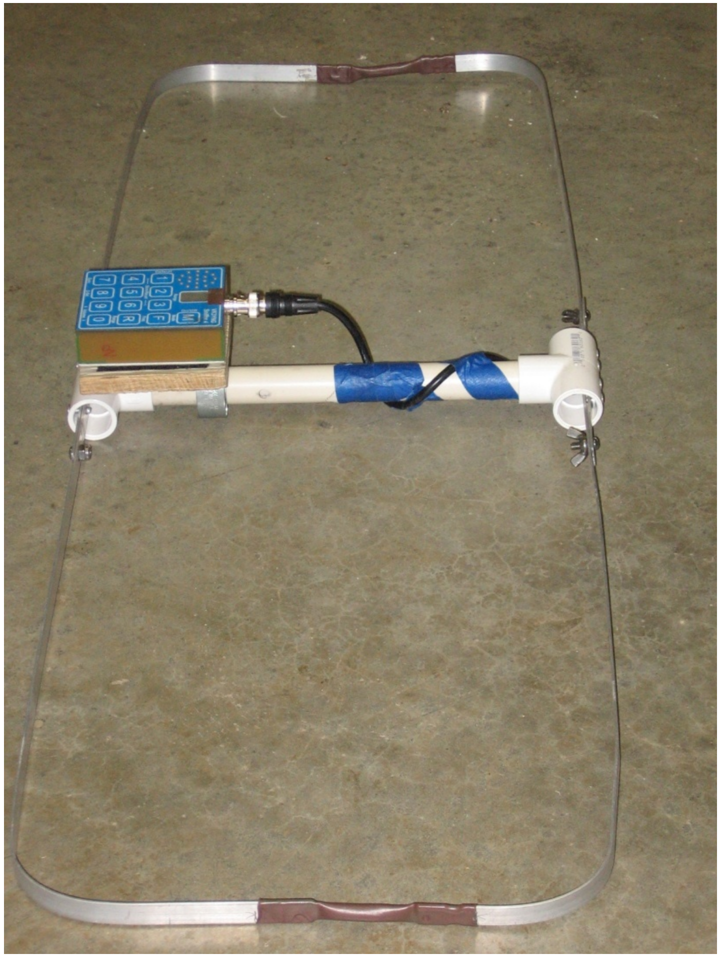


DF receiver is attached directly to the antenna.

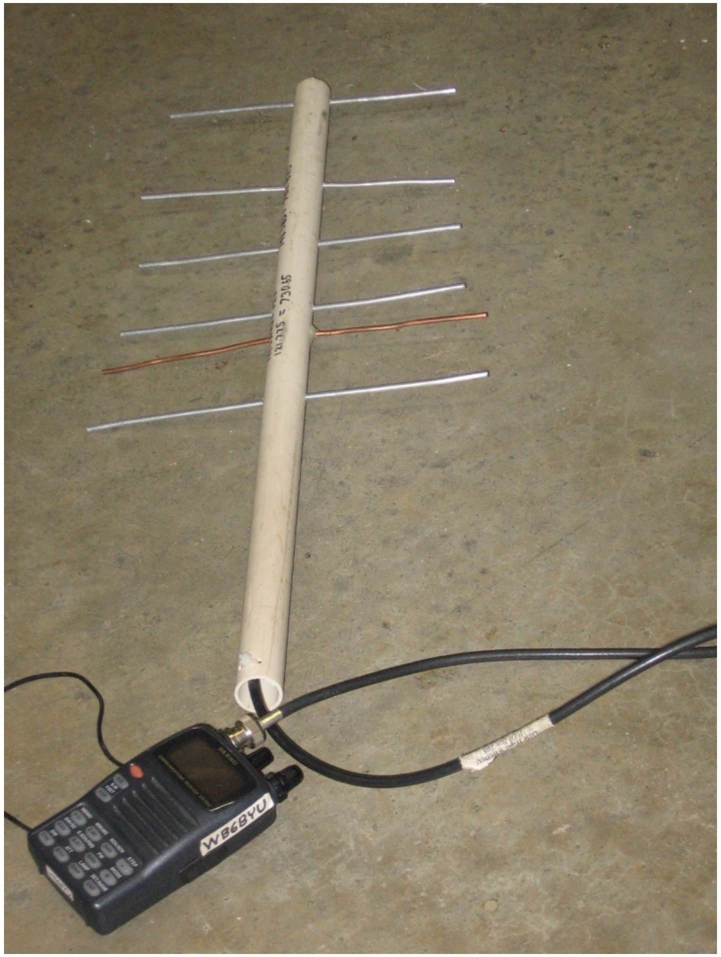
Moxon Antenna for 2m

Short form of yagi antenna.

This one is made from ½” aluminum flat stock and has a DF receiver mounted on the boom



732 MHz Yagi for Harmonic Sniffing

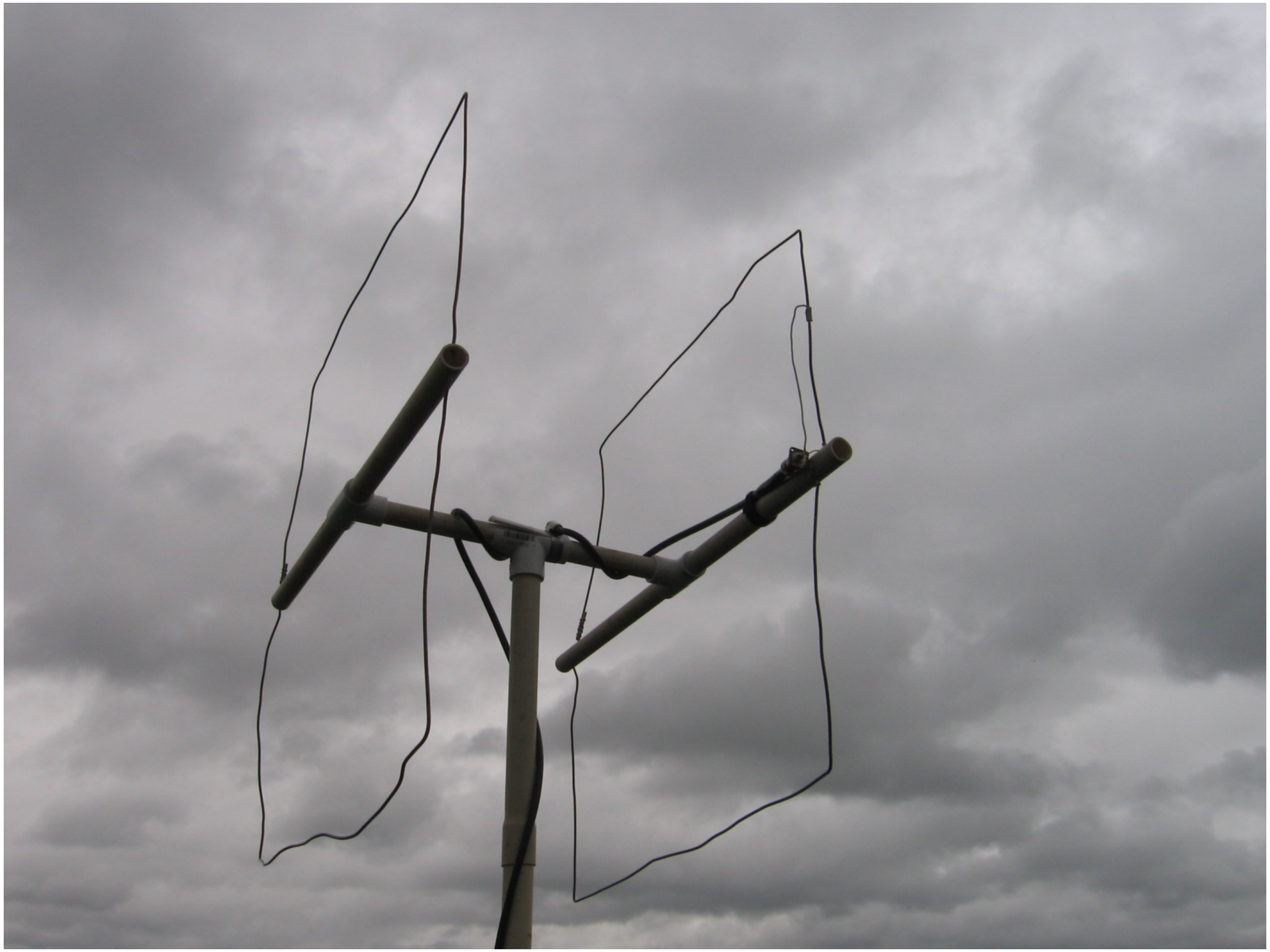


High frequency allows a very sharp pattern in a physically small antenna.

Use to pick up harmonics of the transmitted signal when the fundamental is very strong.

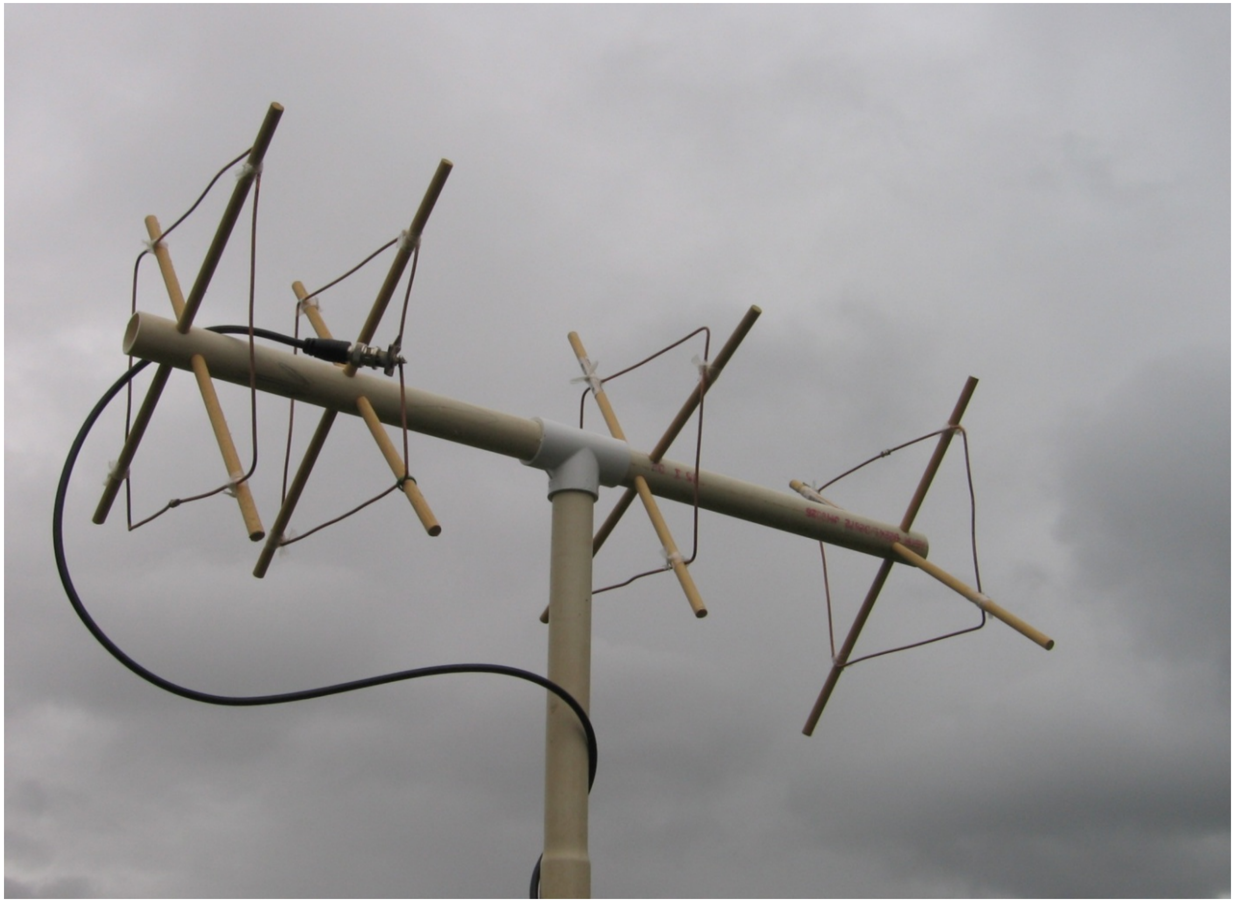
732 MHz is the 5th harmonic of 144 MHz and the 6th harmonic of 121.5 MHz.

2-Element Quad Antenna



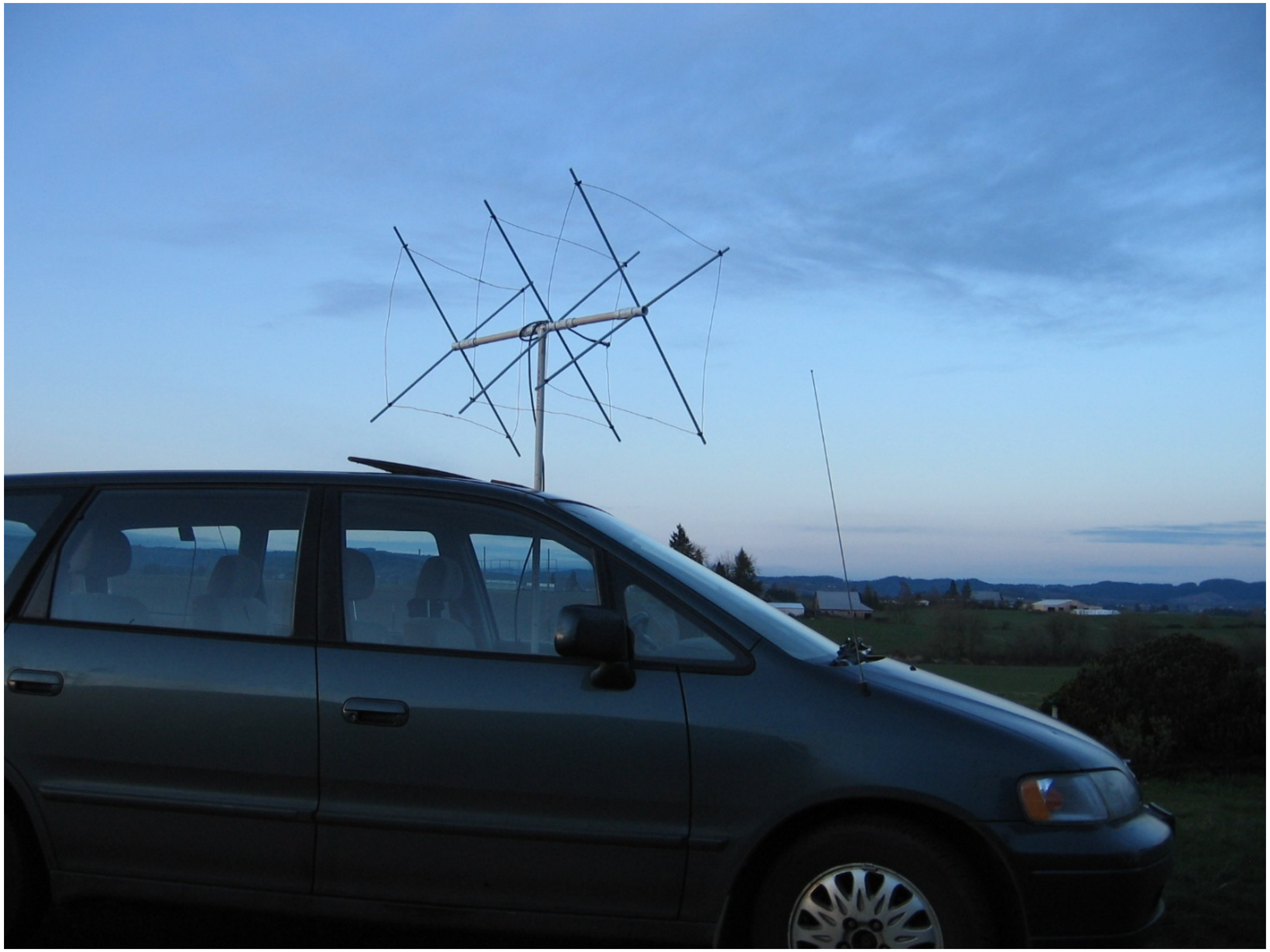
Made from PVC pipe and copper wire.

4-Element Quad for 465 MHz



Improvised from PVC pipe, wood dowels and copper wire in about half an hour to track interference to Sheriff radio system.

How to tell a radio geek…



3-Element quad for 121.5 MHz mounted through the sun roof on my van.

Directional Antenna Resources

- See the Resource pages at the end of the presentation for antenna dimension spreadsheets, web sites, construction information, etc.

Attenuator

- Why do you need one?
  - Signal gets too strong, pins meter in all directions
- Types
  - Waveguide beyond cutoff
  - Resistive attenuator
  - Offset / active attenuator
- May be built into sophisticated receivers.

Stages of a search

- Initial signal acquisition
- Triangulation
- Mobile hunting (“homing”)
- End stage
  - Hunting on foot
  - “sniffing”

Why Practice?

- If you don’t use it regularly, it won’t work in an emergency.

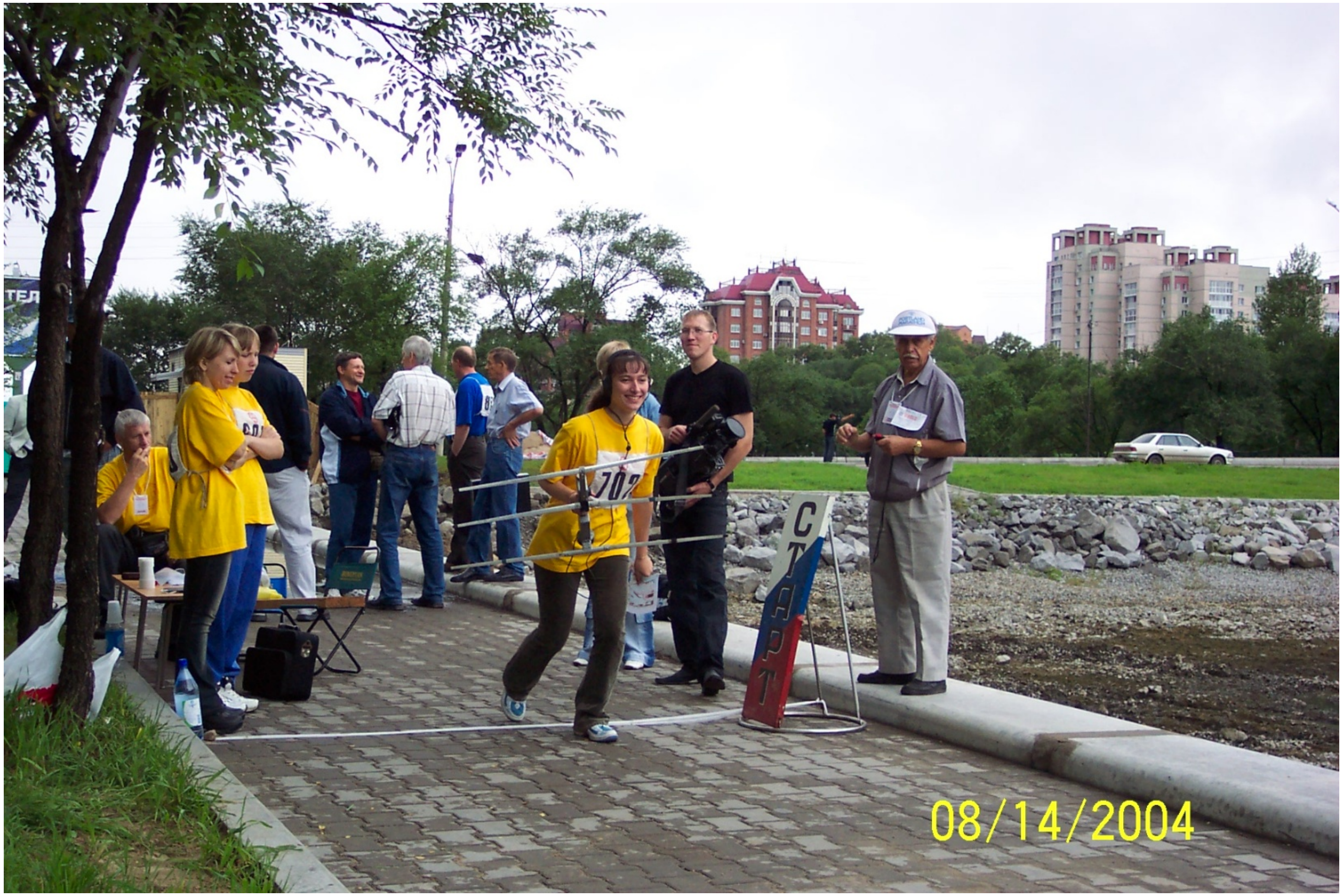
Opportunities for practice

- Very important for developing skills
- Track any convenient signal source
  - Repeaters
  - Net control station
  - Commercial signals
  - FAX machine, etc.
- Set up regular practice sessions
- International competitions (“ARDF”)

ARDF or “Radio Orienteering”

- Done on foot in a large park or forest using map, compass, and DF receiver.
- Course lengths may be 2 to 5 miles with up to 5 transmitters.
- Competitions held on 2m and 80m.
- US Championships held every year.
- Region and World Championships held every other year.

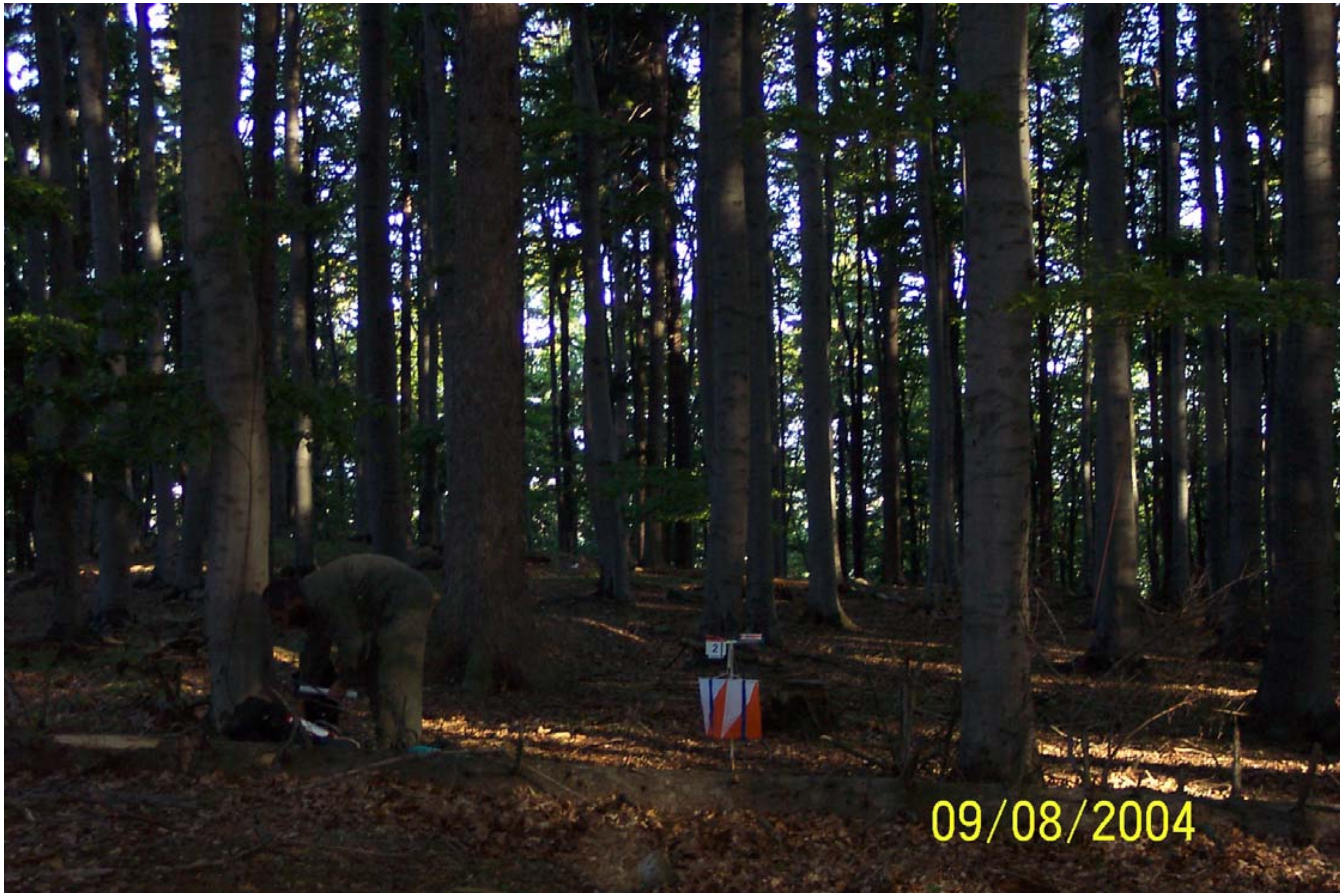
Start of an informal hunt



08/14/2004

Fun For All Ages

Flag is visible from 10’ or more



09/08/2004

Casual or Serious

Even International Competitions can be Relaxed and Friendly

Some Finish Fast

And others are happy just to get there

In spite of the mud, rain, etc…

PRACTICE HUNTS
TODAY AND TOMORROW

- After this session
- Tomorrow afternoon
- Where to meet
- Frequencies
- Equipment available to loan

Summary

- RDF can be important in emergency response.
- Doesn’t require expensive or elaborate equipment (but specialized equipment can make it easier.)
- Equipment often can be improvised to meet a specific need.
- RDF is a skill that requires practice.
- RDF is a fun activity in non-emergency situations, which also provides practice.

Antenna Design Resources

The website of the late LB Cebik, W4RNL, has a huge wealth of antenna information. Free registration is required.

Antenna calculator spreadsheet:

- http://www.cebik.com/content/a10/trans/ant-design.html

Quad and yagi antennas:

- http://www.cebik.com/content/a10/yagi/eq-yag-1.html
- http://www.cebik.com/content/a10/quad/2mq.html
- http://www.cebik.com/content/a10/vhf/scales.html

Practical antenna construction:

- http://www.cebik.com/content/ao/ao1.html
- http://www.cebik.com/content/ao/ao2.html
- http://www.cebik.com/content/ao/ao3.html

Antenna Design Resources (cont.)

Easy yagi antenna construction:

- http://wa5vjb.com/yagi-pdf/cheapyagi.pdf

Calculator for equivalent size of non-round antenna elements:

- http://fermi.la.asu.edu/w9cf/equiv/index.html

More antenna designs:

- http://www.mydarc.de/dk7zb/

Notes on building long yagi antennas:

- http://www.ifwtech.co.uk/g3sek/diy-yagi/index.htm

Calculator for very long yagi antennas:

- http://www.k7mem.150m.com/Electronic_Notebook/antennas/yagi_vhf.html

Other RDF Resources

Many facets of RDF:

- http://www.homingin.com/

Offset Attenuator plans:

- http://www.homingin.com/joek0ov/offatten.html

ARDF as a sport in North and South America:

- http://www.ardf-r2.org/

Commercial DF equipment:

VK3YNG “Blue Box” receiver: http://www.foxhunt.com.au/

L-Tronics direction finders: http://www.ltronics.com/